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Statement to [redacted] by [redacted] 25X1A5a1

SNARK versus B-47

Problem

It is assumed that, if the decision were made now, the U.S. could have a strategic bombing force by 1955 comprising either B-47 planes or SNARK surface to surface missiles. These carriers would have a range permitting their use against almost all important Soviet industrial targets from bases in the U.S, and either the Near East or India. Which would be a "better" system to buy?

Some logical difficulties

What does "better" mean? In general we assume that system A is better than system B if it can "destroy" more at the same "cost" or "destroy" the same amount at less "cost." Unfortunately "destruction" and "cost" are vectors.

Because the bombing errors of the SNARK system are probably greater than those of the B-47 system, a SNARK system, in destroying the explicit target set, will incidentally destroy far more than will the B-47 system: is this "good" or "bad," and by how much? On the cost side, the SNARK system loses missiles, requires launching sites, uses large quantities of fissile material, but has no crew casualties. The B-47 system loses crews, is relatively frugal in its fissile material requirements, requires bases, and may bequeath surviving planes to future campaigns.

Our crude "resolution" of these logical difficulties is to postulate a target set that must be destroyed with a certain probability within a given space of time. Incidental destruction is ignored. The cheapest SNARK and B-47 systems are then estimated. In this estimation crew loses are ignored, no salvage is assumed, and the dollar cost of procurement and operation is employed as an index of real costs. The system having the lower cost is then considered "better."

Assumptions

Before proceding it is necessary to make a great many assumptions, some of which might be:

Campaign job. To have an expectancy of destroying 80 per cent of the target set within two months.

Targets. 100 industrial type targets, of heavy steel frame construction; physical vulnerability .28 miles to 1 kt. blast.

Weapon. A-bomb, of given type: kt to kg relation postulated.

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Bombing accuracy. CEP of B-47 1.0 mile; CEP of SNARK taken at various values ranging from 1.0 to 5.0 miles.

Local defense effectiveness. Various values for θ (see below).

Area defense effectiveness. Various values for ϕ (see below).

Coverage and Attrition

It is impossible to know what a system will cost until one has estimated, among other things, coverage (i.e., the probability that the target will be destroyed by a carrier that has reached the target) and attrition (i.e., one minus the ingoing or outcoming survival expectancy of the carrier).

The probability of destroying a target, treated as a point (p), is

$$1 - \frac{1}{2}\left(\frac{K^{\frac{1}{3}} \cdot V}{C}\right)^2$$

where K is the kt. of the bomb, V is the physical vulnerability of the target, and C is the median probable error.

Attrition, or rather its complement the "probability" of survival of a single aircraft, whether inbound or outbound, may be approximated by

$e^{-\phi\frac{F}{B}}$ against area defenses, and

$e^{-\theta\frac{T}{B}}$ against local defenses, where

F/B is the ratio of fighter numbers to bomber numbers and B/T is the cell size, or number of airplanes assigned per target. The effectiveness parameters, ϕ and θ, include the influence of vulnerable area, speed and altitude.

Optimizing

If one is to compare the cheapest SNARK system with the cheapest B-47 system, one must ascertain the cost of the ~~se~~ cheapest variants of each system. The cost of each system will depend in large measure upon such things as weapon power, cell size, altitude flown, and reconnaissance. These must be varied until an optimum -- or cheapest -- version has been found.

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A strategic bombing system has two principal inputs — planes and kilograms of fissile material. Each of these has a marginal cost and a marginal product. The art is to combine these two inputs in the most economical proportions. The planes to fissile ratio material can be varied in one or both of the following ways. The kg of the bomb can be changed and/or the proportion of escort planes to carrier planes in the cell can be changed. The same applies to warheads and missiles. Within the range of interest, more powerful bombs or warheads will increase the total fissile material requirements but decrease the number of sorties and initial carrier requirements of the system. What is most economical naturally will depend upon the relative costs of procuring and operating another plane or another kilogram of fissile material. We estimate that another B-47 costs $7 million to buy and maintain in readiness, with its crew and base requirements, for four years. The more expensive aircraft are — whether planes or missiles — the less desirable it is to combine a number of decoy escorts with the carrier.

Snark missiles and B-47 planes can be flown at various altitudes during penetration and attack. A different speed is associated with each alternative altitude. In general high altitude means less attrition, but high altitude also means more wasted bombs as a quadrupling of slant range doubles CEP. A balance must be struck, and this balance is also sensitive to the relative cost of the delivery system and the bomb.

It is clearly wasteful to "over kill" targets, and yet this may happen. In a missile system one does not know whether the last sortie destroyed the target unless — in the absence of ground agents — a reconnaissance sortie is run. If missile guidance is very poor, the probability of destroying a target on any one sortie is low; it would hence be extravagant to take a "look" after each attack sortie. In other words an optimum frequency of "looking" must be calculated, and this will also depend upon the relative costs of the carrier system, reconnaissance system, and bombs or warheads. In the case of the aircraft system the planes in the cell have a certain probability of performing their own BDA and surviving the return trip.

<u>Uncertainties Affecting the Final Decision</u>

The final decision between a SNARK and a B-47 system — or between any airplane and missile system for strategic bombing — will implicitly assume one or more combinations of values for such uncertain future imponderables as the target system, the level of enemy defenses, and the length of the preparedness period.

<u>The target system.</u> The importance of bombing accuracy depends upon the size and vulnerability of the targets to be attacked. Industrial plant targets are small and "hard"; cities on the other hand are large and "soft." If SNARK has a comparatively high CEP it will have a comparative disadvantage against plant targets and a comparative advantage against city targets. What will be the target system in 1955 and thereafter?

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Enemy defense level. Optimum cell sizes, weapon kt, and reconnaissance frequency all depend upon the relative cost of fissile material and a sortie. The cost of procuring a B-47 system and maintaining it for four years is about $7 millions per plane. The cost per sortie is $7 millions divided by the number of completed penetrations to target. The latter will be $s/(1 - s^2)$ for an airplane, where s is the probability of surviving inbound and this is similar to the outbound survival probability. The cost per completed inbound sortie for a SNARK however is about $.37 millions divided by s. Hence an increase in attrition from say s = .9 to .6 increases the cost of an airplane delivery by about 3 times and that of a missile delivery by about 1.5 times. Higher enemy defenses, that result in increased attrition, work a comparative disadvantage upon the B-47 system. What will be the enemy defense level in 1955 and thereafter?

Preparedness period length. It is anticipated that the SNARK will have a higher CEP than the B-47 system. It is economical to compensate for this higher CEP with a higher lethal radius which in turn means a larger kt and more kg. A much higher percentage of the total cost of the missile system will be for fissile material than will that of the airplane system. Now fissile material occasions almost no additional costs after it has been procured. On the other hand it costs almost a million dollars a year per plane to maintain a B-47 system in readiness. The missile system has larger stock costs and lower flow costs than does the plane system. In retrospect, if the preparedness period proves to be short, one would congratulate oneself if one had procured the plane system, and vice versa. What will be the length of the preparedness period?

System analyses such as these can never provide the perfect answer. It would be fatuous to suppose that logic and computations suffice to know the future. System analyses are of the "if, then" type and their answers are no better than the assumptions and parameters introduced into them. However they have the great merit of focusing attention upon the assumption and parameters that policy makers should attempt to assess. And they provide an apparatus, within the outer suppositions, for determining optimum tactics and operating procedures.

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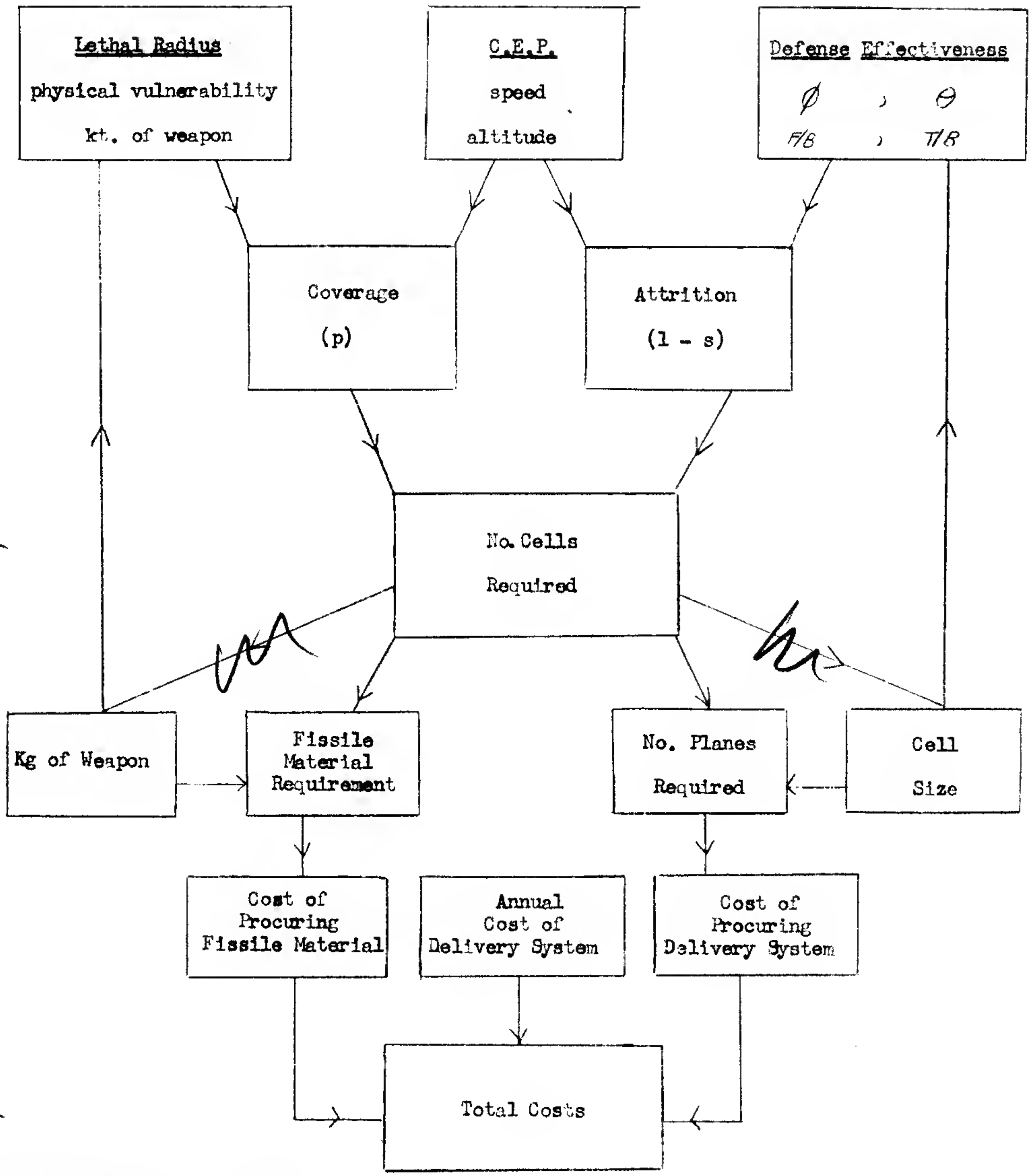

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